GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL

[ ] REVISION NO. ____

Project No. A-3025 DATE: 8/27/81

Project Director: Hank Jackson School/Lab TAL/ECD

Sponsor: Georgia Department of Transportation; Atlanta, GA

Type Agreement: Task order #1-1 under Basic Contract dated 3/1/81 (unno. 54).

Award Period: From 8/19/81 To 9/23/81 (Performance) ---- (Reports

Sponsor Amount: $2,616 Contracted through:

Cost Sharing: N/A GTRI/~~GTT~~

Title: Energy Management Survey of Aerial Survey Lab and Thomaston District Office

ADMINISTRATIVE DATA OCA CONTACT Leamon R. Scott

1) Sponsor Technical Contact: Hugh L. Tyner, Chief; Research & Development Bureau; Department of Transportation; Office of Materials & Research; 15 Kennedy Drive; Forest Park, GA 30050

2) Sponsor Admin./Contractual Contact: same

Reports: See Deliverable Schedule Security Classification: N/A

Defense Priority Rating: N/A

RESTRICTIONS

See Attached ____ Supplemental Information Sheet for Additional Require

Travel: No travel outside state of Georgia shall be allowed unless such travel is listed in cost estimate or approved in writing in advance. Also, prior approval required to increase amount of travel shown in cost estimate.

Equipment: Title vests with sponsor

COMMENTS:

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting Office
Research Security Services
✓ Reports Coordinator (OCA)
Legal Services (OCA)
EES Research Public Rela
Project File (OCA)
Other: ____

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 1/4/82

Project Title: Energy Management Survey of Aerial Survey Lab and Thomaston District Offic

Project No: A-3025

Project Director: Hank Jackson

Sponsor: Georgia Dept. of Transportation; Atlanta, GA

Effective Termination Date: 9/23/81

Clearance of Accounting Charges: 9/23/81

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and Closing Documents
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: TAL/ECD (School/Laboratory)

COPIES TO:

Administrative Coordinator	Research Security Services	EES Public Relations (2)
Research Property Management	Reports Coordinator (OCA) ✓	Computer Input
Accounting	Legal Services (OCA)	Project File
Procurement/EES Supply Services	Library	Other _____

FORM OCA 10:781

A-3025

ENERGY MANAGEMENT REPORT

THOMASTON DISTRICT OFFICE

Prepared For

RESEARCH AND DEVELOPMENT BUREAU

GEORGIA DEPARTMENT OF TRANSPORTATION

FOREST PARK, GEORGIA

Prepared by

David E. Keith, P.E.

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY

ATLANTA, GEORGIA

EES Project A-3025

September 10, 1981

Disclaimer

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I. EXECUTIVE SUMMARY

Energy consumption at your plant for the twelve-month period, August 11, 1980 through August 10, 1981 consisted of:

- 291,320 KWH of electricity
- 5565 ccf of natural gas

This is equivalent to 1551 million BTU's of energy. Total energy costs for the period were $19,222.06.

The energy conservation opportunities (ECO's) contained in this report could save an estimated 607 million BTU's each year, or 39% of your total usage. The annual cost savings would amount to approximately $7028, or 37% of your annual energy costs. This figure is based on average energy costs for the past twelve month period. In light of rapidly increasing energy costs, your actual savings may be much greater. You should compare your current energy costs to the average costs used in this report, and adjust the cost savings upward proportionately. The recommendations are:

		Energy Savings BTU x 10^6	Cost Savings $
1.	Enclose carport (already being done)	98	$1046
2.	Reduce lighting levels	35	588
3.	Outside lights-photocell	1	24
4.	Storm windows	152	1630
5.	High efficiency bulbs	21	349
6.	Wall insulation	141	1550
7.	Air conditioning maintenance	66	825
8.	Roof insulation	93	1016

II. ENERGY MANAGEMENT

Rising energy costs and repeated energy shortages will determine the future of many companies. To meet this challenge, a successful company must have an energy management program to consistently take advantage of every energy conservation opportunity. Several basic steps are required for effective energy management:

- Management Commitment
- Data Analysis
- Goal Setting
- Analysis of Conservation Opportunities
- Implementation of Conservation Techniques
- Continued Feedback and Analysis

The Energy Management program must have the commitment of management for it to produce a long term increase in energy efficiency. A brief, early show of support will only result in small, temporary improvements. Management must design the conservation program as part of its regular, overall company management system. Also, energy costs and the consequences of future energy shortages should be widely disseminated to create an overall energy awareness.

Information must be recorded at regular intervals to support the energy management program. Utility bills and production records may already contain much of the information required. These sources would be adequate to calculate overall energy costs and to determine production efficiency in terms of how much energy is required to manufacture one unit of production. Existing information will probably not detail energy use in each production step, however. Allowances must be made in designing the information base to allow more detailed breakdown of energy consumption as this information becomes available.

Data analysis will be greatly aided if the records use a standard format for all the company's divisions and if the different energy units (such as killowatt-hours of electricity, gallons of oil, etc.) are converted to a common energy unit, the BTU (British Thermal Unit). One BTU is the amount of energy needed to raise the temperature of one pound of water one degree fahrenheit. By comparing the cost of various fuels on the bais of cost per million BTU's ($/MMBTU), the true cost of each fuel can be determined. The

conversion factors required are:

ENERGY UNIT	ENERGY EQUIVALENT
1 kwh	3,412 BTU
1 Therm	100,000 BTU
1 Cu Ft Natural Gas	1,000 BTU*
1 Gallon #2 Oil	140,000 BTU*
1 Gallon #6 Oil	152,000 BTU*
1 Gallon Propane	91,600 BTU*
1 Ton Coal	28,000,000 BTU*

*Varies slightly with supplier.

On a regular basis, whether monthly or annually, progress toward conservation goals should be examined and a new set of goals defined. All goal setting will depend on the opportunities for energy conservation which data analysis has uncovered. More detailed information on specific mechanisms may be required as the program continues the search for energy waste. Forms such as those in the next section should be used as a minimum to aid in the measurement and analysis of energy conservation efforts. Additional forms are enclosed in the appendix for your future use.

Job No. A-3025

Date: 9-3-81

ENERGY CONSUMPTION - PAST 12 MONTHS

Name: Georgia State Highway Department - Thomaston District Office

Address: 715 Andrews Drive, Thomaston, GA 30286

Power Distributor: City of Thomaston

Account Number: 8032-00

Minimum Bill _____ Contract Demand Cost: _____

Demand Not Metered

Meter Reading Date Mo/Day/Yr	Actual Degree Days		Electric						
	HDD	CDD	kWh	kW	kVa	Billing Demand	L.F.	P.F.	Cost
Jan 10, 1981			22,120						$ 1,298.44
Feb 10, 1981			24,880						1,456.00
Mar 10, 1981			21,480						1,224.39
Apr 10, 1981			19,200						1,138.80
May 10, 1981			23,480						1,361.79
Jun 10, 1981			19,640						1,140.00
Jul 10, 1981			30,280						1,747.80
Aug 10, 1981			29,240*						1,687.71
Sep 10, 1980			32,600						1,920.00
Oct 10, 1980			30,080						1,784.84
Nov 10, 1980			19,520						1,224.92
Dec 10, 1980			18,800						1,155.23
Totals			291,320						$17,139.92

Yearly Peak Electric Demand: _____ kW (For buildings over 100,000 gross ft.^{2})

Annual Peak Electric Demand: _____ kW

*latest bill = $\frac{\$1687.71}{29,240 \text{ KWH}}$ = 5.8 ¢/KWH

Fossil Fuels

Meter Reading Date Mo/Day/Yr	Actual Degree Days		Natural Gas		L.P. Gas		Fuel Oil		Coal		Cost
	HDD	CDD	CCF	Cost	Gallons	Cost	Gallons	Cost	Ton	Cost	Total
Jan 26, 81			1748	667.11							
Feb 24, 81			1154	446.05							
Mar 25, 81			596	238.34							
Apr 23, 81			164	70.51							
May 26, 81			64	30.07							
Jun 24, 81			49	23.89							
Jul 24, 81			37	20.03*							
Aug 25, 80			78	28.65							
Sep 25, 81			88	32.49							
Oct 27, 80			123	43.48							
Nov 25, 80			514	169.98							
Dec 27, 80			950	311.54							
Totals			5565	$2082.14							

*latest bill = $\frac{\$20.03}{37 \text{ ccf}}$ = 54 ¢/ccf

Job No. A-3025-2

ECO No. 1

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 1

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Carport area underneath the main floor exposes floor and walls to outside conditions, adding to heat gain/loss.

2. Recommendation: The carport is now being enclosed by DOT. The energy and cost savings expected are summarized below.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		291,320	5565				$19,902
Rec. Cond.		278,320	5025				18,856
Net Reduction		13,000	540				1,046

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ -

Estimated useful life of this recommendation in years -

Salvage Value $ - Disposal Cost $ -

Estimated cost for design, acquisition & installation of recommended change $ -

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}}$ = $\frac{-}{-}$ = - years

M-2025-2
9-8-81
DAE

ECO-1 Enclose carport (now being enacted)

The effect of enclosing the basement carport area will be to reduce heat loss/gain through the building floor and NE wall.

wall heat loss/gain = $\frac{A}{\Sigma R} = \frac{38' \times 10'}{2.98} = 295 \frac{Btu}{hr\,°F}$

floor heat loss/gain = $\frac{43' \times 176'}{17.73} = 476 \frac{Btu}{hr\,°F}$

TOTAL = $771 \frac{Btu}{hr\,°F}$

Previous total bldg heat loss/gain coefficient, including ventilation and infiltration, was 7970 Btu/hr·°F, so this measure will decrease consumption by about 10%

Heating, gas savings $0.10 \left(5400 \frac{ccf}{yr}\right) = 540 \frac{ccf}{yr}$

Cooling, compressor/condenser unit electric savings

$0.10 \left(133{,}000 \frac{kWh}{yr}\right) = 13{,}000 \frac{kWh}{yr}$

Cost savings

$13{,}000 \frac{kWh}{yr}\ 5.8 \frac{¢}{kWh} + 540 \frac{ccf}{yr}\ 54 \frac{¢}{ccf} = \$1046$/yr

Job No. A-3025-2

ECO No. 2

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type 4

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Lighting levels excessive in some areas.

2. Recommendation: Selectively remove 2 bulbs from certain 4-bulb fluorescent fixtures based on light-meter readings. May keep 4 bulbs in fixtures above desks. Disconnect ballasts on fixtures when removing bulbs.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		278,320					$16,143
Rec. Cond.		268,195					15,555
Net Reduction		10,125					588

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ -

Estimated useful life of this recommendation in years -

Salvage Value $ - Disposal Cost $ -

Estimated cost for design, acquisition & installation of recommended change $ 180

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{\$180}{\$588/\text{yr}} = 0.3$ years

A-3025-2
9-8-81

ECO-2 Lighting levels excessive in some areas.

Measurements made:

Preconstruction room	110-150 foot-candles (f.c.)
personnel/accounting	120 f.c.
right of way	140-200
traffic safety	200

---

of the 180 4ft x 4 bulb flourescent fixtures, probably 1/4 can be "delamped" - that is two bulbs removed and ballast disconnected. Maintain 4 bulbs in fixtures directly over desks

$\frac{180}{4} = 45$ fixtures

power reduction 100 W/fixture

total = 4.5 kW

at 2250 $\frac{hr}{yr}$ operation,

energy savings = 10,125 $\frac{kWh}{yr}$

cost savings @ 5.8 ¢/kWh = $584/yr

estimated electrician time to disconnect ballasts
= 12 man-hours ($1\frac{1}{2}$ days)
assume $15/man-hour (including overhead)

payback period = $\frac{\$180}{\$584/yr}$ = 3.7 months

Job No. A-3025-2

ECO No. 3

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 4

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Outside lights under manual control and are left on during daylight hours on week ends and holidays.

2. Recommendation: Install photocell control to automatically switch on and off lights, depending on daylight conditions.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		268,195					$15,555
Rec. Cond.		267,785					15,531
Net Reduction		410					24

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ -

Estimated useful life of this recommendation in years 10

Salvage Value $ - Disposal Cost $ -

Estimated cost for design, acquisition & installation of recommended change $ 45

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{\$45}{\$24/\text{yr}} = 1.9$ years

A-3025-2
9-8-81
DAK

ECO-3 Outside lighting - timer or photocell

Outside lights presently controlled manually by switch in lobby. Therefore they are left on during the daylight hours on weekends and holidays.

Holidays : 10 days/yr

Weekends : 2 × 52 = 104 days/yr

total = 114 days/yr

average 12 hr/day

total = 1368 hrs/yr

2 (150 watt fixtures) = 0.3 kW

0.3 kW (1368 $\frac{hr}{yr}$) = 410 $\frac{kWh}{yr}$ daylight operation

cost of daylight operation @ 5.8 ¢/kWh = $23.80/yr.

Estimated cost to install photocell control for light switching:

cost of control :	$15.00
electrician 2 hrs @ $15	30.00
Total	$45.00

payback period = $\frac{\$45.00}{23.80\ \$/yr}$ = 1.9 yrs

Job No. A-3025-2

ECO No. 4

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 3

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Single glazed windows

2. Recommendation: Add storm windows

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		267,785	5025				$18,245
Rec. Cond.		247,385	4199				16,615
Net Reduction		20,400	826				1,630

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ 0

Estimated useful life of this recommendation in years 15

Salvage Value $ 0 Disposal Cost $ 0

Estimated cost for design, acquisition & installation of recommended change $4500

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{4500}{\$1630/\text{yr}} = 2.8$ years

A-3025-2
9-8-81
DAK

ECO-4 Storm windows

Present energy cost of single glazed windows:

45 windows, each $3'3\frac{1}{4}" \times 10'$

transmission $A = 1472\ ft^2$

$U = 1.13\ \frac{Btu}{hr\ ft^2\ °F}$

$UA = 1762\ \frac{Btu}{hr\ °F}$

infiltration total = $1800\ \frac{Btu}{hr\ °F}$

Existing windows = $3562\ \frac{Btu}{hr\ °F}$ (including infiltration)

Total building heat loss/gain = $7200\ \frac{Btu}{hr\ °F}$

Revised, with storm windows:

$U = 0.55\ \frac{Btu}{hr\ ft^2\ °F}$

$UA = 810\ \frac{Btu}{hr\ °F}$

assume infiltration reduced by 1/6

net reduction = $(1762 - 810) + 300 = 1252\ \frac{Btu}{hr\ °F}$

After enclosing carport:

savings = $\frac{1252}{7970 - 771}\ \frac{Btu/hr\ °F}{Btu/hr\ °F} = 0.17$ (17%)

Heating savings

$0.17\ (5400 - 570) = 826$ ccf

Cooling savings (compressor/condenser units)

$0.17\ (133{,}000 - 13{,}000) = 20{,}400$ kWh

Cost savings @ 5.8 ¢/kWh & 54 ¢/ccf

$20{,}400\ (0.058\ \frac{¢}{kWh}) + 826\ (0.54\ \frac{¢}{ccf}) = \$1630/yr$

Cost (ref Means 1981 Cost Data)

windows: $82 ea. labor: $18 total = $100 ea (approx.)

TOTAL cost $45 \times \$100 = \$4500$

Payback period = $\frac{\$4500}{\$1630/yr} = 2.8$ yrs.

Job No. A-3025-2

ECO No. 5

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 4

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Standard 40 watt fluorescent bulbs are used.

2. Recommendation: Change over to 35 watt high efficiency bulbs.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		247,385					$14,348
Rec. Cond.		241,371					13,999
Net Reduction		6,014					349

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ 0

Estimated useful life of this recommendation in years 8

Salvage Value $ 0 Disposal Cost $ 0

Estimated cost for design, acquisition & installation of recommended change $ 1188

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{\$1188}{\$349/\text{yr}} = 3.4$ years

A-3025-2
9-8-81
DAK

ECO-5 Lighting

The use of energy-conserving (34-35 watt) bulbs should be instituted on a replacement basis for 40w bulbs as they burn out. They provide nearly as much light, while reducing energy consumption by about 12%.

Alternatively, a complete change-over of all bulbs should be considered. Assume de-lamping ECO already enacted:

$(180-45) \times 4$ bulbs = 540 bulbs

$(9+45) \times 2$ bulbs = 54

TOTAL = 594 bulbs

Present energy usage of bulbs (ignore ballasts), assume about 90% in use at any given time

$$594 \text{ bulbs } (0.90)\ 40 \frac{w}{\text{bulb}}\ 2250 \frac{hr}{yr}\ \frac{1}{1000} \frac{kW}{w} = 48{,}114 \frac{kWh}{yr}$$

Proposed energy usage, 35W bulbs

$$594 \text{ bulbs } (0.90)\ 35 \frac{w}{\text{bulb}}\ 2250 \frac{hr}{yr}\ \frac{1}{1000} \frac{w}{kw} = 42{,}099 \frac{kWh}{yr}$$

Energy savings = $48{,}114 - 42{,}099 \frac{kWh}{yr} = 6014 \frac{kWh}{yr}$

Cost savings @ $5.8 \frac{¢}{kWh} = \$349/yr$

Cost to implement @ $\$2$/bulb; assumes no-cost labor (janitorial/maint. existing staff)

$\$2 \times 594 = \$1188$

payback period = $\frac{\$1188}{\$349/yr} = 3.4$ yrs

Job No. A-3025-2

ECO No. 6

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 2

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Walls are uninsulated.

2. Recommendation: Spray on urethane foam insulation on walls and paint.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		241,371	4199				$16,266
Rec. Cond.		221,371	3470				14,716
Net Reduction		20,000	729				1,550

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ 0

Estimated useful life of this recommendation in years 20

Salvage Value $ 0 Disposal Cost $ 0

Estimated cost for design, acquisition & installation of recommended change $ 5230

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{\$5230}{\$1550/\text{yr}} = 3.4$ years

A-3025-2
9-9-81
OAK

ECO-6 Wall insulation

Existing walls are uninsulated

transmission coefficient thru walls:

total $R = 2.98$

Area = 4358 sq. ft.

$$UA = \frac{A}{\Sigma R} = \frac{4358}{2.98} = 1462 \ \text{Btu/hr °F}$$

Total heat loss/gain (after carport is enclosed)

$$7970 - 771 = 7199 \ \text{Btu/hr °F}$$

Percentage of this loss/gain attributable to walls:

$$\frac{1462}{7199} = 20\%$$

Present cost of the heat loss/gain thru walls:

heating: $0.20 \left(5400 - 540\right) \frac{\text{ccf}}{\text{yr}} = 987 \ \text{ccf/yr}$

cooling: $0.20 \left(133{,}000 \ \frac{\text{kwh}}{\text{yr}}\right) = 26{,}000 \ \frac{\text{kwh}}{\text{yr}}$

cost $987 \text{ ccf } \frac{\$0.54}{\text{ccf}} + 26{,}000 \text{ kwh } \frac{\$0.058}{\text{kwh}} = \$2041/\text{yr}$

Proposed: add 1" thick urethane foam, sprayed on, $R = 7.7$

Revised total $R = 7.7 + 2.98 = 10.68$

$UA = 408 \ \text{Btu/hr °F}$

net reduction: $1462 - 408 = 1054 \ \frac{\text{Btu}}{\text{hr °F}}$

$\frac{1054}{7199} = 15\%$ savings (or 75% of wall heat loss/gain)

Savings:

heating: $0.15 \left(5400 - 540\right) = 729$ ccf saved

cooling $0.15 \left(133{,}000\right) = 20{,}000$ kwh

cost saved: $5.4¢ \left(729\right) + 5.8¢ \left(20{,}000\right) = \$1550/\text{yr}$

Installation cost:

ref Means 1981 p 119 - sprayed on walls = $1.03 /sq.ft.

Painting @ $0.17 /sq.ft. total = $1.20

+358 sqft $1.20/sqft = $5230

Payback period = $8720 ÷ $1550/yr = 3.4 yrs.

Job No. A-3025-2

ECO No. 7

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 9

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Construction causing dusty conditions, low air flow in some areas (file room), coil (evaporator) on air-handler in new section is iced-over.

2. Recommendation: Charge refigerant, clean coils, clean fans and ducts, after construction is completed.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		221,371	3470				$14,716
Rec. Cond.		209,571	3210				13,891
Net Reduction		11,800	260				825

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ 0

Estimated useful life of this recommendation in years 5

Salvage Value $ 0 Disposal Cost $ 0

Estimated cost for design, acquisition & installation of recommended change $3000

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{\$3000}{\$600/\text{yr (average)}} = 5$ years

A-3025-2
9-8-81

ECO-7 Air conditioning cleaning

General maintenance on the air conditioning system appears warranted: 1. evaporator coil in air-handler was iced-over (rear section)
2. low air flow was observed in at least one area (file room).

Charging of refrigerant, cleaning coils, and cleaning fan and ducts recommended, after present construction is completed.

Expected savings; air conditioning, compressor consumption est. 10% savings

present consumption (est.):
$(23.2 + 37.2)\,kW \; 2000 \frac{hr}{yr} = 120{,}800 \frac{kWh}{yr}$

estimated consumption following service:
$1800 \frac{hr}{yr} \; (60.4\,kW) = 109{,}000 \frac{kWh}{yr}$

energy savings = $11{,}800 \frac{kWh}{yr}$

cost savings @ $5.5 \frac{¢}{kWh}$ = $649/yr

Expected savings, gas consumption reduced due to improved heat transfer efficiency ≈ 5%

present heating gas = 5191 ccf/yr

expected heating gas = 0.95 (5191) = 4931 ccf/yr

energy savings = 260 ccf/yr

cost savings @ 54 ¢/ccf = $141/yr

Total savings = $825/yr (1st yr); 700; 600; 500, 400

Estimated cost of service: $3000

Payback period = $\frac{\$3000}{\$600/yr}$ = 5 yrs

Job No. A-3025-2

ECO No. 8

ENERGY CONSERVATION OPPORTUNITY

Customer: DOT Thomaston District Office

ECO Type _ 2

1.	Building envelope	5.	Hot Water	9.	Ventilation	13.	Solar
2.	Insulation	6.	Food services	10.	Heat Pump	14.	O&M procedure
3.	Storm windows/doors	7.	Heating	11.	Process energy	15.	Capacitors
4.	Lighting	8.	Cooling	12.	Production equipment	99.	Miscellaneous

1. Existing conditions: Limited insulation in roof of old section.

2. Recommendation: Spray on urethane foam on top of existing roof, one-inch thick for addtional R = 7.7.

3. Existing vs. recommended conditions

	Electric		Fossil Fuels				
	kW	kWh	Nat. Gas (cc ft.)	LP Gas (gal)	Oil (gal)	Coal (tons)	Annual Cost
Exist. Cond.		209,571	3210				$13,891
Rec. Cond.		196,571	2724				12,875
Net Reduction		13,000	486				1,016

4. Cost Analysis:

Estimated decrease/increase in maintenance cost resulting from this ECO. $ 0

Estimated useful life of this recommendation in years 30

Salvage Value $ 0 Disposal Cost $ 0

Estimated cost for design, acquisition & installation of recommended change $ 10,000

Payback period = $\frac{\text{Cost of change}}{\text{Net reduced annual cost}} = \frac{\$10,000}{\$1016/yr} = 9.9$ years

A-3025-2
9-8-81
OAK

ECO-8 Roof insulation - old section

Present energy cost of ceiling, 10,560 sq ft

$UA = 1388 \frac{Btu}{hr \cdot °F}$

Total building heat loss/grid = 7200 $\frac{Btu}{hr \cdot °F}$ (carport enclosed)

Revised spray on urethane foam on top of existing roof
1" thick
R = 7.7 additional

revised $U = 0.06$
$UA = 676$ Btu/hr °F

savings = $1388 - 676 = 712 \frac{Btu}{hr \cdot °F}$

$\frac{712}{7200}$ = approx 10% savings

Energy & cost savings
heating = $0.10 (4860 \frac{ccf}{yr}) = 486$ ccf/yr

cooling (compressor/condenser units only)
$= 0.10 (133{,}000 \frac{KWH}{yr}) = 13{,}000$ KWH/yr

Cost savings @ 5.8 ¢/KWH & 54 ¢/ccf

$13{,}000 (0.058) + 486 (0.54) = \$1016/yr$

Cost of installation
ref Means 1981 cost data
materials (urethane, spray on) $0.22/sq ft
labor $0.52/sq.ft.
TOTAL (including overhead & profit) $0.95

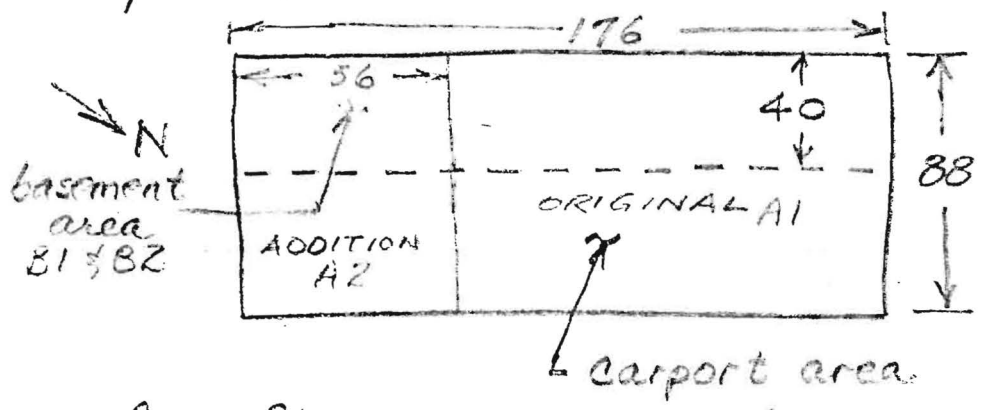
cost = $0.95 (10,560 sq ft)

Payback period = $\frac{\$10{,}000}{\$1016/yr} = 9.9$ yrs

A-3025-2
9-3-81
DAK

DOT Thomaston District office – Energy analysis

Summary



first floor : 15,488 sq ft
basement : 7,040 sq ft
TOTAL 22,528 sq ft

AREAS

A1-B1 original construction : 1956 = 15,360 sq ft
A2-B2 addition : 1966, added 56 ft on S side, including basement, = 7168 sq ft
addition : 1981 (under construction at time of survey) enclose carport area into office space, add new boiler for whole bldg heat, add air handler and AC compressor/condenser unit to serve 1981 add'n

1981 addition not considered in this report.

Total energy consumption, annual :

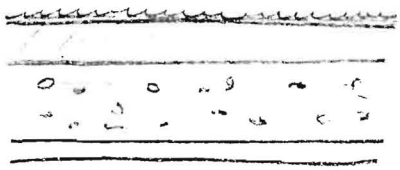
electric	291,320 kWh	$= 9.94 \times 10^8$ Btu	($17,140)
gas	5,565 ccf	$= 5.70 \times 10^6$ Btu	($2,082)
	total	1.00×10^9 Btu	($19,222)

Square ft. basis 44,390 $\frac{\text{Btu}}{\text{sq ft}}$; $0.85/sq. ft.

A-3025-2
9-3-81
OAK

Building envelope

Roof sections: AREA A1

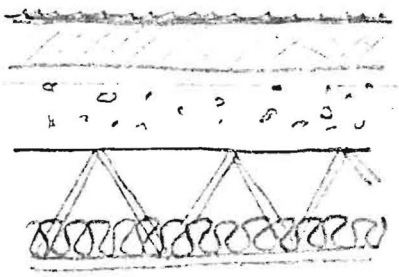


	R
Outside air	0.17
Built-up roof	0.33
1" Rigid insul.	2.79
2" gypsum concrete	1.20
1" acoustical formbd.	2.50
Inside air	0.62
$\Sigma R =$	7.61

A = Roof area A1 = 88 x 120 = 10,560 ft²

$$UA = \frac{A}{\Sigma R} = 1388 \frac{Btu}{hr\,°F}$$

AREA A2



Outside air	0.17
Built-up roof	0.33
1" Rigid insul.	2.79
2" Gypsum conc.	1.20
Air space	0.98
3½" fiberglas batts	11.00
½" suspended ac. tile	1.25
Inside surface	0.62
$\Sigma R =$	18.34

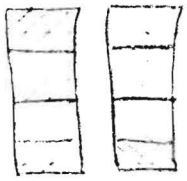
A = roof area A2 = 88 x 56 = 4928 ft²

$$UA = \frac{A}{\Sigma R} = 269 \frac{Btu}{hr\,°F}$$

basement roof sections B1 & B2 not considered, because adjoining unheated/cooled space.

A-3025 - ?
9-3-21
DAK

Walls (Ignore wall in basement facing ground)



	R
outside air	0.17
4" face brick	0.44
air space	0.98
4" conc. block	0.71
inside surface	0.68
ΣR =	2.98

Wall area = $10' \{(176 \times 2) + (88 \times 2) + (40 \times 2)\}$

minus doors & windows

$6080 ft^2 - 1559 - 163 = 4358 ft^2$

$UA = \frac{A}{\Sigma R} = \frac{4358}{2.98} = 1462 \ Btu/hr \cdot °F$

Windows

45 @ $3'3\frac{1}{4}" \times 10'$ = $147 ft^2$

2 @ $2' \times 6'8"$ = $27 ft^2$

1 @ 6×10 = $60 ft^2$

$1559 ft^2$ $U = 1.13$

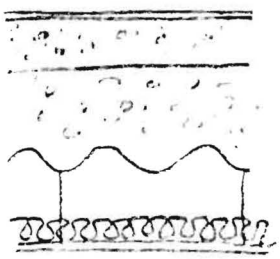
$UA = 1559 \times 1.13 \ Btu/hr ft^2 \cdot °F = 1762 \ \frac{Btu}{hr \cdot °F}$

Doors

2	6'x7'	hollow metal w/2 $2\frac{1}{2}' \times 5'$ windows	$U = 1.05$
1	6x7	hollow metal, no windows	$U = 0.89$
2	3x7	hollow metal	$U = 0.89$

$UA = 84 ft^2 \times 1.05 + 42 ft^2 \times 0.89 + 42 ft^2 \times 0.89 = 163 \ \frac{Btu}{hr \cdot °F}$

Floor (above carport, now being enclosed)



inside surface	0.62
asphalt tile	0.05
2" concrete	0.22
4" vermiculite-sand conc.	3.44
corrugated deck	0
air space	0.98
3½" fiberglas batts	11.00
formboard clg	1.25
outside surface	0.17
ΣR =	17.73

A-3025-2
9-3-81
DAK

Floor cont'd

$$UA = \frac{A}{\Sigma R} = \frac{48 \times 176}{17.73} = 476 \frac{Btu}{hr\,°F}$$

Ventilation and infiltration

Bldg conditions - avg. tightness, some opening windows
assume 0.5 air changes/hr infiltration

Ventilation - outside air

spec't: old air handler = 1950 cfm o.a.
new section a.h. = 1000 cfm o.a. (estimated)
2950 cfm o.a.

design ventilation = 2950 cfm o.a. $60 \frac{min}{hr}$ = 177,000 $\frac{ft^3}{hr}$

Outside air damper in old section found fully open,
assume ventilation = 2500 cfm (old section)
actual ventilation (est.) = 3500 cfm $60 \frac{min}{hr}$ = 210,000 $\frac{ft^3}{hr}$.

Building volume = 22,528 ft^2 9 ft (clg. ht.) = 202,752 ft^3

Infiltration 0.5 (202,752 $\frac{ft^3}{hr}$) = 101,000 ft^3/hr

heat loss/gain =

$$\dot{m} c_p = 101{,}000 \frac{ft^3}{hr}\ 0.075 \frac{lb}{ft^3}\ 0.24 \frac{Btu}{lb\,°F} = 1800 \frac{Btu}{hr\,°F}$$

Ventilation heat loss/gain

$$\dot{m} c_p = 210{,}000 \frac{ft^3}{hr}\ 0.075 \frac{lb}{ft^3}\ 0.24 \frac{Btu}{lb\,°F} = 3800 \frac{Btu}{hr\,°F}$$

A-3025-2
9-3-81
DAK

Floor, cont'd

$$UA = \frac{A}{\Sigma R} = \frac{48' \times 176'}{17.73} = 476 \frac{Btu}{hr\,°F}$$

Ventilation

very little outside air used.
Old bldg - damper was closed
New bldg - damper nearly closed

assume 600 cfm

$$\text{volume/hr} = 600 \frac{ft^3}{min} \; 60 \frac{min}{hr} = 36{,}000 \frac{ft^3}{hr}$$

heat loss/gain = mass flow x specific heat

$$36{,}000 \frac{ft^3}{hr} \; 0.075 \frac{lb}{ft^3} \; 0.24 \frac{Btu}{lb\,°F} = 650 \frac{Btu}{hr\,°F}$$

Infiltration

building conditions relatively "tight", assume
0.5 air change per hour
bldg. vol. = 200,000 cu. ft.

$$\left(\frac{0.5}{hr}\right)(200{,}000 \text{ cu. ft.}) = 100{,}000 \frac{cu.ft}{hr}$$

heat loss/gain

$$100{,}000 \frac{ft^3}{hr} \; 0.075 \frac{lb}{ft^3} \; 0.24 \frac{Btu}{lb\,°F} = 1800 \frac{Btu}{hr\,°F}$$

Total building loads

Transmission		
roof (old)	1388	Btu/hr.°F
roof (new)	269	
walls	1462	
windows	1762	
doors	163	
floor	476	
Ventilation	650	
Infiltration @0.5 $\frac{\text{air chg}}{\text{hr}}$	1800	
$\Sigma =$	7970	Btu/hr.°F

Annual heating requirement

2400 HDD (ref: Talbotton GA)

$$\frac{7970 \frac{\text{Btu}}{\text{hr}\cdot°\text{F}} \; 2400 \frac{°\text{F day}}{\text{yr}} \; 24 \frac{\text{hr}}{\text{day}} \; (0.85)}{(0.70)} = 5.57 \times 10^8 \frac{\text{Btu}}{\text{yr}}$$

0.85 - degree day credit factor for time clock with night set-back (15% saving)

0.70 - boiler & system heat transfer efficiency
boiler (0.80) · system = (0.87)

$$\text{gas req'd} = \frac{5.32 \times 10^8 \frac{\text{Btu}}{\text{yr}}}{102{,}400 \frac{\text{Btu}}{\text{ccf}}} = 5443 \text{ ccf/yr}$$

Energy Balance

Lighting

Incandescent

29	@ 150 W	=	4350 W
1	@ 100 W	=	100 W
63	@ 60 W	=	3780 W
4	@ 20 W	=	80 W
			8310 W = 8.3 kW

Flourescent

180 ea 4 bulb 4 ft	@	200 W	= 36,000 W (incl. ballast)
9 ea 2 bulb 4 ft	@	100 W	= 900 W
16 ea 2 bulb 8 ft	@	200 W	= 3,200 W
14 ea 1 bulb 8 ft	@	100 W	= 1,400 W
11 circ.	@	40 W	= 440 W
8 ea 1 bulb 2 ft	@	25 W	= 200 W
			42,140 W = 42.1 kW

Total lighting = 50.4 kW avg 40 kW on
avg 2250 hr/yr = 90,000 kWh

Building equipment

UNIT	kW (total)	HRS/YR	KWH
air compressor	0.8	100	80 kWh
unit heaters (8)	13.2	300	3960
terminal (computer)	1.0	500	500
refrigerators	3.0	1500	4500
cold drink machines	2.0	1500	3000
small copier	1.5	500	2250
large copier	3.5	800	2800
blueline	10.0	1000	10000
coffee, microwave, etc.	5.0	200	1000
misc.	3.0	500	1500
			29,590 kWh

round off 30,000

HVAC

Air handlers:

New bldg

fan = 3.0 kW
hrs operation = 3000/yr

energy = 3.0 kW 3000 $\frac{hr}{yr}$ = 9,000 kWh

Old bldg

fan = 10.0 kW
hrs operation = 3000/yr

energy = 10 kW x 3000 $\frac{hr}{yr}$ = 30,000 kWh

A/C Compressor-condenser units

New bldg. (Bryant)

Compressors (2) 36 A 208 V 3ϕ = 10.4 kW ea.
Condenser fans (4) 3.6 A 208 V 1ϕ = 0.6 kW ea
total = 2(10.4) + 4(0.6) = 23.2 kW

Old bldg (York)

Compressor 120 A 208 V 3ϕ = 34.6 kW
condenser fans (4) 3.9A 208 V 1ϕ = 0.65 kW ea
total = 34.6 + 4(0.65) = 37.2 kW

Large self-contained unit (Rheem) above stairs

Compressor 14.7 A 208 V 1ϕ = 2.5 kW
fans 3.8A 208 V 1ϕ = 0.63 kW
total = 2.5 + 0.63 = 3.13 kW

Two window units 1.5 kW each

Total A/C = 66.53 kW

@ 2000 $\frac{hr}{yr}$ equivalent full load hours

= 133,000 kWh

ENERGY CONSUMPTION - PAST 12 MONTHS

Name: _____

Address: _____

Power Distributor: _____

Account Number: _____

Minimum Bill _____ Contract Demand Cost: _____

Meter Reading Date Mo/Day/Yr	Actual Degree Days		Electric						
	HDD	CDD	kWh	kW	kVa	Billing Demand	L.F.	P.F.	Cost
Jan									
Feb									
Mar									
Apr									
May									
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									
Totals									

My Peak Electric Demand: _____kW (For buildings over 100,000 gross ft.^{2})

Total Peak Electric Demand: _____kW

Fossil Fuels

Meter Reading Date Mo/Day/Yr	Actual Degree Days		Natural Gas		L.P. Gas		Fuel Oil		Coal		Cost
	HDD	CDD	CCF	Cost	Gallons	Cost	Gallons	Cost	Ton	Cost	Total
Jan											
Feb											
Mar											
Apr											
May											
Jun											
Jul											
Aug											
Sep											
Oct											
Nov											
Dec											
Totals											